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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/645,645	08/22/2003	Chandra Mouli	M4065.0674/P674	8786

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EXAMINER	
MATTHEWS, COLLEEN ANN	

ART UNIT	PAPER NUMBER
2811	

DATE MAILED: 11/02/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/645,645	MOULI, CHANDRA	
	Examiner	Art Unit	
	Colleen A. Matthews	2811	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *18 August 2006*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-37* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-37* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Applicant's election with traverse of Species 1 in the reply filed on 08/18/2006 is acknowledged. The traversal is on the ground(s) that the only claim of Species 2, claim 19, could be examined with the rest of the claims without serious burden. This is found persuasive and the restriction requirement is withdrawn.

Specification

The disclosure is objected to because of the following informalities:

Specification page 16, paragraph 70 uses references numerals that do not correspond to the Figures such as pixel cell 700, transfer gate 760. Also paragraph 80 uses pixel cell 800. Please review specification for other similar inconsistencies between the figures and the description.

Appropriate correction is required.

Claim Rejections - 35 USC § 112

1. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

2. **Claims 15 and 28** are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

3. **Regarding claims 15 and 28**, the transistor of claims 1 and 20 is designed for "transferring the amplified charge from the photodiode" (claim 1 lines 7-8, claim 20 lines lines 9-10), thus describing a transfer transistor. It is unclear if the reset transistor of claims 15 and 28 is meant to be the same transfer transistor as the antecedent basis

requires, which would then require the transistor to be both a transfer transistor and a reset transistor or if the reset transistor is meant to be a separate transistor from the transfer transistor.

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

2. **Claims 1, 11 and 15-19** are rejected under 35 U.S.C. 102(b) as being anticipated by U.S. Pat. No. 6,232,626 to Rhodes.

3. **Regarding claim 1,** Rhodes discloses a pixel cell for an image sensor, the pixel comprising: a a photodiode (24) for generating charge in reponse to light and for amplifying the generated charge, the photodiode being over a surface of the substrate and comprising a plurality of layers (100,102), wherein at least a first layer (100) where at least a first layer has a first band gap and at least a second layer has a second band gap and a gate of a transistor (28) adjacent to the photodiode for transferring the amplified charge from the photodiode.

4. **Regarding claim 11,** Rhodes discloses the pixel cell of claim 1 where at least a portion (under light area 12) of the photodiode (24) is at a level below a level of a top surface of the substrate.

5. **Regarding claim 15**, as far as the claim can be understood Rhodes discloses the pixel cell of claim 1, where there is a reset transistor (31) for resetting the photodiode to a predetermined voltage.

6. **Regarding claim 16**, Rhodes discloses the pixel cell of claim 1, further comprising a floating diffusion region (30), where the transistor (28) is a transfer transistor for transferring charge from the photodiode to the floating diffusion region (col 3 lines 24-27).

7. **Regarding claim 17**, Rhodes discloses the pixel cell of claim 1 where the photodiode is part of a CMOS image sensor (col 2 lines 44-49).

8. **Regarding claim 18**, Rhodes discloses the pixel cell of claim 1 where the photodiode is part of a charge coupled device image sensor (col 2 lines 44-49).

9. **Regarding claim 19**, Rhodes discloses the pixel cell of claim 1 where the substrate is a silicon-on-insulator substrate (Rhodes, col 6 lines 46-50).

Claim Rejections - 35 USC § 103

10. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

11. **Claims 2-3, 5-8, 12-13 and 32-34** are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Pat. No. 6,232,626 to Rhodes in view of U.S. Pat. No. 5,818,322 to Tasumi.

12. **Regarding claims 5 and 6,** Rhodes discloses the pixel cell of claim 1 as above. Rhodes fails to disclose the layers formed of a material selected from the group consisting of Si, Si_xGe_{1-x}, $Si_xGe_{1-x}C_y$, GaAs, GaAlAs, InP, InGaAs, or InGaAsP and where the first layer is Si and the second layer is SiGe. Tasumi teaches a photodiode structure (Figures 1A-1C element 2) with Si and SiGe (col 3 line 63) formed in the groove (4) of the photodiode. It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Rhodes to include the alternating layers of Si and SiGe as in Tasumi in order to layer improve the photodiode device performance.

13. **Regarding claims 2 and 3**, Rhodes as modified by Tasumi above fails to explicitly teach a difference between the valence band energies of the Si and SiGe layers as greater than a difference between the conduction band energies. However, this feature is inherent in Rhodes as modified by Tasumi since the same materials are used for the photodiode.

14. **Regarding claims 7 and 8,** Rhodes as modified by Tasumi discloses the photodiode comprising at least four layers of Si and at least four layers of SiGe, where the layers of Si are doped to a first conductivity type and the layers of SiGe as taught by Tasumi are doped to a second conductivity type (col 5 lines 66-67 and col 6 lines 1-32) where the layers of Si are alternated with layers of SiGe to form an Si/SiGe structure (6).

15. **Regarding claims 9 and 10,** Rhodes as modified by Tasumi discloses the pixel cell of claim 1 where the first layer is Si_xGe_{1-x} or $Si_xGe_{1-x}C_y$ and the second layer is Si_yGe_{1-y} or $Si_xGe_yC_z$.

16. **Regarding claim 12,** Rhodes as modified by Tasumi discloses the photodiode comprises approximately 10 to approximately 100 layers, Tasumi has 22 layers (Figure 1A), which falls within the claimed range.

17. **Regarding claim 13,** Rhodes as modified by Tasumi above fails to disclose forming the layers of thickness of approximately 50 – 300 angstroms. However, this difference is regarded as nothing more than an obvious design variation of the dimension of the thickness and the variation could be easily ascertained through routine experimentation. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use the thickness of the layers between 50 – 300 angstroms in order to maximize the performance of the device.

18. **Regarding claims 32-34,** Rhodes discloses an image sensor comprising an array of pixel cells where at least one of the pixel cells comprises a photodiode (24), the photodiode comprising layers (100, 102) and a gate (28) adjacent to the photodiode for transferring the amplified charge form the photodiode.

Rhodes fails to disclose the photodiode comprising alternating layers of Si and Si_xGe_{1-x}, where x is approximately 0.5. Tasumi teaches a photodiode structure (Figures 1A-1C element 2) with Si and Si_xGe_{1-x}, (col 3 line 63) where x is 0.6 (col 1 line 32) which is approximately 0.5 formed in the groove (4) of the photodiode. It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify

Rhodes to include the alternating layers of Si and Si_xGe_{1-x} as in Tasumi in order to layer improve the photodiode device performance.

19. **Claims 14** is rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Pat. No. 6,232,626 to Rhodes in view of U.S. Pub. No. 2004/0079408 to Fetzer et al. (Fetzer).

20. **Regarding claim 14,** Rhodes discloses a pixel cell for an image sensor, the pixel comprising: a a photodiode (24) for generating charge in response to light and for amplifying the generated charge, the photodiode being over a surface of the substrate and comprising a plurality of layers (100,102), wherein at least a first layer (100) where at least a first layer has a first band gap and at least a second layer has a second band gap and a gate of a transistor (28) adjacent to the photodiode for transferring the amplified charge from the photodiode.

Rhodes fails to disclose a graded buffer layer between a bottom layer of the photodiode and a surface of the substrate. Fetzer discloses use of graded buffer layers (402-416) between a device (420) and a surface of the substrate (62, paragraph 13 lines 25-27). It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Rhodes to include a graded buffer layer between a bottom layer of the photodiode and a surface of the substrate as in Fetzer in order to improve the photodiode cell performance.

21. **Claims 4, 20 and 28-31** are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Pat. No. 6,232,626 to Rhodes in view of U.S. Pat. No. 6,127,692 to Sugawa et al. (Sugawa).

22. **Regarding claims 4 and 20,** Rhodes discloses the pixel cell of claim 1 as above. Rhodes also discloses an image sensor comprising an array of pixel (Figure 4) cell at the surface of a substate, where at least one of the pixel cells comprises a photodiode (24), the photodiode comprising a plurality of layers (100, 102), where the layers are configured such that there is a difference between the conduction band energies of the first and at least second materials, a gate of a transistor adjacent to the photodiode for transferring the amplified charge from the photodiode (col 2 lines 18-19).

Rhodes fails to disclose the difference between the valence band energies of the first material to at least a second material configured to promote ionization of a first carrier type and suppressing ionizing of a second carrier type. Sugawa discloses the promoting ionization of a first carrier type and suppressing ionizing of a second carrier type (col 3 lines 14-17). It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Rhodes to have the promoting ionization of a first carrier type and suppressing ionizing of a second carrier type as in Sugawa in order to improve the photodiode cell performance.

23. **Regarding claim 28**, as far as the claim can be understood Rhodes discloses the image sensor cell of claim 20, where there is a reset transistor (31) for resetting the photodiode to a predetermined voltage.

24. **Regarding claim 29**, Rhodes discloses the image sensor of claim 20, further comprising a floating diffusion region (30), where the transistor (28) is a transfer transistor for transferring charge from the photodiode to the floating diffusion region (col 3 lines 24-27).

25. **Regarding claim 30**, Rhodes discloses the image sensor of claim 20, where the pixel cell further comprises readout circuitry (Figure 1 transistors 36 and 38) connected (by wire 44) to a floating diffusion region (30) for reading out charge.

26. **Regarding claim 31**, Rhodes discloses the image sensor of claim 20, further comprising circuitry (Figure 1 transistors 36 and 38) peripheral to the array, the peripheral circuitry being at a surface of the substrate, where the substrate is silicon-on-insulator (Rhodes, col 6 lines 46-50).

27. **Claims 21-27 and 35-37** are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Pat. No. 6,232,626 to Rhodes in view of U.S. Pat. No. 6,127,692 to Sugawa et al. (Sugawa) in further view of U.S. Pat. No. 5,818,322 to Tasumi.

28. **Regarding claims 21 and 22,** Rhodes as modified discloses the image sensor of claim 20 as above. Rhodes fails to disclose the layers of material selected from the group consisting of Si, Si_xGe_{1-x}, $Si_xGe_{1-x}C_y$, GaAs, GaAlAs, InP, InGaAs, or InGaAsP and where the first layer is Si and the second layer is SiGe. Tasumi teaches a photodiode structure (Figures 1A-1C element 2) with Si and SiGe (col 3 line 63) formed in the groove (4) of the photodiode. It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Rhodes to include the alternating

layers of Si and SiGe as in Tasumi in order to layer improve the photodiode device performance.

29. **Regarding claims 23 and 24,** Rhodes as modified by Tasumi discloses the photodiode comprising at least four layers of Si and at least four layers of SiGe, where the layers of Si are doped to a first conductivity type and the layers of SiGe as taught by Tasumi are doped to a second conductivity type (col 5 lines 66-67 and col 6 lines 1-32) where the layers of Si are alternated with layers of SiGe to form an Si/SiGe structure (6).

30. **Regarding claims 25 and 26,** Rhodes as modified by Tasumi discloses the pixel cell of claim 1 where the first layer is Si_xGe_{1-x} or $Si_xGe_{1-x}C_y$ and the second layer is Si_yGe_{1-y} or $Si_xGe_yC_z$.

31. **Regarding claim 27,** Rhodes as modified by Tasumi dislcoes the photodiode comprising approximately 10 to approximately 100 layers, Tasumi has 22 layers (Figure 1A), which falls within the claimed range.

32. **Regarding claims 35,** Rhodes discloses a processor system, comprising a processor (444) and an an image sensor coupled to the processor, the image sensor comprising an array of pixel cells where at least one of the pixel cells comprises a photodiode (24), the photodiode comprising layers (100, 102) and a gate (28) adjacent to the photodiode for transferring the amplified charge form the photodiode, a floating diffusion region (30) electrically connected to the first transistor and readout circuitry (Figure 1 transistors 36 and 38) electrically connected to the floating diffusion region.

33.

Rhodes fails to disclose the difference between layers configured to promote ionization of a first carrier type and suppressing ionizing of a second carrier type. Sugawa discloses the promoting ionization of a first carrier type and suppressing ionizing of a second carrier type (col 3 lines 14-17). It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Rhodes to have the promoting ionization of a first carrier type and suppressing ionizing of a second carrier type as in Sugawa in order to improve the photodiode cell performance.

Rhodes also fails to disclose the layers formed of a material selected from the group consisting of Si, Si_xGe_{1-x}, $Si_xGe_{1-x}C_y$, GaAs, GaAlAs, InP, InGaAs, or InGaAsP and where the first layer is Si and the second layer is SiGe. Tasumi teaches a photodiode structure (Figures 1A-1C element 2) with Si and SiGe (col 3 line 63) formed in the groove (4) of the photodiode. It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Rhodes to include the alternating layers of Si and SiGe as in Tasumi in order to layer improve the photodiode device performance.

34. **Regarding claims 36 and 37**, Rhodes as modified by Tasumi fails to explicitly teach a difference between the valence band energies of the first and second materials as greater than a difference between the conduction band energies. However, this feature is inherent in Rhodes as modified by Tasumi since the same materials are used for the photodiode.

Response to Arguments

Applicant's arguments filed 05/15/2006 with respect to claims 1-37 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Colleen A. Matthews whose telephone number is 571-272-1667. The examiner can normally be reached on Monday - Friday 8AM-4:30PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Richard Elms can be reached on 571-272-1869. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Douglas W. Owens 10/30/06

CAM
10/30/2006

DOUGLAS W. OWENS
PRIMARY EXAMINER